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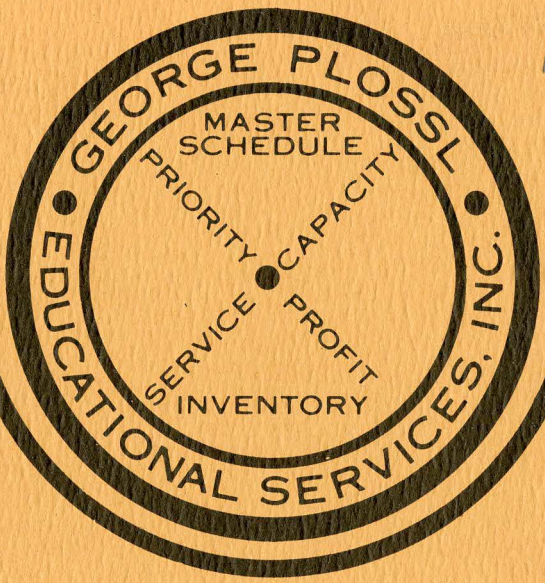

Reschedule The Reschedules You Just Rescheduled— Way of Life for MRP?

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RESCHEDULE THE RESCHEDULES YOU JUST RESCHEDULED - WAY OF LIFE FOR MRP?

An MRP program suggests rescheduling of open orders for a part to suit changing needs. This is the prime use of MRP and its major contribution in a manufacturing control system. There are numerous reasons why needs change, some externally induced and some internally within the MRP program itself. Too often MRP supplies too many reschedule orders for planners to evaluate and handle. More logic programmed in the computer has been suggested to reduce this number of exceptions to an acceptable level. A better approach is to identify causes of reschedules and eliminate them wherever possible. The balance remaining should then be within the capability of the planners to manage.

This article will identify many reasons for nervousness in MRP and suggest ways of minimizing or eliminating them altogether. Only after this has been done should "dampening logic" be considered, because of the risk of blunting the effectiveness of this priority planning technique.

WHAT IS RESCHEDULING?

Rescheduling is the term applied to changing the required due date on a released replenishment order for either purchased or manufactured material. The recommended change can expedite, delay or cancel the order. This change in required due date can come from many sources and be related to many problems.

Rescheduling orders to suit revised need dates has become a viable approach since the advent of material requirements planning (MRP) based systems. A technique, such as MRP, that plans requirements to support a master production schedule through the bills of material has the ability to keep need dates on orders up to date.

A picture displaying the MRP logic is shown as Figure 1.

This figure shows four levels in a bill of material; the finished product, a major assembly, a sub-assembly and a purchased component. Typically, finished products are made up from several major assemblies, each major assembly is made from several sub-assemblies and each sub-assembly is made from many components. A master production schedule (MPS) for the finished product is at the top, showing the quantities to be produced each week. Quantities of major assemblies that are required to be finished, ready to issue to the final product manufacture, are calculated using the bill of materials (Qty. per assy. = 1).These requirements for finished major assemblies are netted (deducted) from the on-hand inventory (Have Now) and any open replenishment orders by time period (Will Get). Shortages (Needs) are then shown. With a lead time of one week, the planned order issue (Start) period for these orders can be calculated.

A sub-assembly that is needed to make the major assembly is shown next. The requirements for finished sub-assemblies to be in inventory are calculated using the bill of materials (Qty. per assy. = 1). Obviously, finished sub-assemblies are required at the same time orders for the major assembly are scheduled to be started. The same logic is used netting on-hand inventory and open orders to calculate the needs for the sub-assembly. With a two-week lead time, the start period of the planned orders is calculated.

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FIGURE 1

Finished Product
Master Production Schedule

Week No.	Past Due	1	2	3	4	5	6	7	8
Will make			20		30		25		35

Major Assembly
Lead Time = 1 wk Lot Size = Lot-for-Lot

Require			20		30		25		35
Have Now (10)									
Will Get			10						
Need					30		25		35
Start				30		25		35	

Sub Assembly
Lead Time = 2 wks Lot Size = Lot-for-Lot

Require				30		25		35	
Have Now									
Will Get				30					
Need						25		35	
Start				25		35			

Purchased Component
Lead Time = 4 wks Lot Size = 100

Require				25		35			
Have Now (40)									
Will Get									
Need						20			
Start		100							

A purchased component is used to make the sub-assembly (Qty. per assy. = 1). Identical logic is used for this part. The lead time is four weeks and there is a minimum order quantity of 100, which should be placed with the vendor in week #1.

The same logic of calculating requirements, netting against on-hand inventory and open replenishment orders and predicting the start of new orders can be used for all items in the bill of materials.

A change in finished product requirements will cause a change in demand on the lower level components, see Figure 2.

Increasing from 20 units of the finished product scheduled in week #2 to 40 will change the demands on the major assembly, sub-assembly and purchased component. This will cause a rescheduling message on the sub-assembly; the open order of 30 in period 3 is now required in period 1. The purchase order for the component will have to be released immediately and the material obtained in less than normal lead time.

Similarly, referring back to Figure 1, if the purchased component is unobtainable in period 5, then the sub-assembly order cannot be released on schedule. Rescheduling the sub-assembly order into a later period will change the need dates on all other components in the sub-assembly bill of material. This item could be rescheduled later to minimize the inventory investment and maximize use of capacity. These goals are not met if all of the other items are received or manufactured on schedule when one component necessary to make the sub-asssembly cannot be obtained.

FIGURE 2

Finished Product
Master Production Schedule

Week No.	Past Due	1	2	3	4	5	6	7	8
Will Make			40		30		25		35

Major Assembly
Lead Time = 1 wk Lot Size = Lot-for-Lot

Require			40		30		25		35
Have Now (10)									
Will Get			10						
Need			20		30		25		35
Start		20		30		25		35	

Sub Assembly
Lead Time = 2 wks Lot Size = Lot-for-Lot

Require		20		30		25		35	
Have Now									
Will Get				30					
Need				20		25		35	
Start		20		25		35			

Purchased Component
Lead Time = 4 wks Lot Size = 100

Require		20		25		35			
Have Now (40)									
Will Get									
Need				5		35			
Start	100								

The logic of MRP to create these rescheduling messages is straightforward. An open order that is coming in too late results in a negative available balance or below safety stock condition in a particular week and can cause an action notice to "Expedite this order". When an order is coming in too soon, the available inventory will exceed what is necessary to support a particular schedule and rescheduling into a later time period is indicated.

Each of these action conditions needs to be analyzed to determine what steps should be taken. After this analysis some specific action is necessary to get the open order schedule changed to an earlier or later date. This work load of making formal changes to the due dates of open orders is normally the most extensive and time consuming job of any MRP-based system.

WHY DO IT?

Manufacturing companies operate in a dynamic environment. Customers have changing demands for products and these changes must be handled to have optimum customer service and minimum inventory investment at the same time. If the requirements for finished products have changed, replenishment orders for the related major assemblies, sub-assemblies and components need to be changed. This will enable the capacity of the plant and vendors to be applied to the needed items based on the latest information. Scarce materials can be used specifically to satisfy the true needs from customers, rather than being tied up in inventory for which there are no immediate requirements.

Probably the most important reason, though, is to replace informal systems with a formal one. A good manufacturing control system will know and react to what is happening on the manufacturing floor. This means that a system must have the ability to replan and keep priorities of open orders valid and in step with the realities of the manufacturing environment. This capability is lacking in most manufacturing systems today; the informal systems of expediting and hot lists are needed to bridge this gap. Rescheduling information supplies the missing data.

WHAT CAUSES RESCHEDULING ?

There are a multitude of causes of rescheduling messages from an MRP-based system. The important causes will be looked at to understand what is needed to control them. Other conditions may be found that are not covered by this article; these should also be investigated and analyzed in a similar manner. (Reference 1 has already described some of these problems.)

MPS CHANGES

The MRP program will be driven by a master production schedule that states what will be built, when it will be built and how much will be built. Frequently this includes customer orders already booked. Revisions to the scheduled delivery dates for their orders may be requested by customers. As the MPS reflects these changes, many items at lower levels in the bills of material will have their requirements changed, probably causing rescheduling messages on open replenishment orders.

The master production schedule usually includes a forecast of future business. This forecast is often revised on a regular basis and revision could result in changes which would permeate through the bills of material to lower level items. Month to month deviations of actual orders from forecast will change the on-hand inventory of finished goods. Replenishment orders for finished goods will then be needed at a different time causing reschedules to open orders for lower level components.

Frequently companies master schedule finished products in families and use the percent of historical usage of each item in the family to determine its share of the family master schedule. This percentage is up-dated statistically in some master scheduling programs. As a particular finished item's usage varies from its historical percentage, its individual master schedule will change and the unique components necessary to make this item in the family will be rescheduled. This would happen even though the total in the master schedule for the family did not change. The percentage bill of materials for options or variants to a basic product will have a similar effect.

Another problem arises because of the difficulty of master scheduling repair (replacement) items demand. These are usually very numerous so their requirements are normally fed into the MRP program based on some regularly updated, computer generated, statistical forecasting routine. As these forecasts are revised and actual demand varies from forecast, requirements and inventory balances will change, not only for the repair items, but also for all components of their bills of materials. Rescheduling of orders will result.

Many companies have affiliate plants supplied by the main plant with some of their parts. Demands from affiliate plants cover many different part numbers, are often erratic and involve large quantities. As the user plant changes its demands on the supplier plant, rescheduling notices will be generated for these parts and parts within the bills of material of any assemblies involved.

VENDOR/PLANT FALL-DOWN

A vendor could be late delivering some material or the quantity delivered might be inadequate to cover immediate requirements. The planned order requiring this material will be late starting or for a reduced quantity so the plan should be adjusted to ensure related components will have the correct priority. This change to the planned order will generate rescheduling messages on open orders for all of its components.

Similarly, problems in the plant such as machine breakdown, tooling trouble, scrap, absenteeism, etc., that change manufacturing's ability to product components on time can delay starting assemblies on which these components are used. When the planning system is notified of such delays, it issues rescheduling messages for all the components that make up the assembled item.

SCRAP/SPOILAGE

Open replenishment orders for a particular assembly or part are one of the factors determining when a new planned order for this item should be released. Unexpected scrap or spoilage on open orders causes planned orders to be needed earlier. In Figure 1. the order for ten of the major assembly has just had five pieces scrapped. The sub-assembly order for thirty due in period 3 will now be required in period 1. Unexpected scrap always causes firm or planned orders to be needed earlier and generates an expediting condition on all lower level items, with corresponding rescheduling notices.

Some computer programs attempt to compensate for reasonably predictable loss or "yield" by use of a scrap factor or shrinkage allowance. This is an estimate of the average loss. If less is scrapped than was covered by the scrap factor, the next planned order for this item will be delayed, permitting delaying of lower level parts. If more is scrapped than planned, the reverse will happen.

LOT-SIZE CHANGES

The lot-size of planned orders for a parent item is "exploded" through its bill of materials to set requirements on the next lower level items. When this lot-size is changed, requirements at lower levels will change, causing rescheduling of released orders involved. This will be particularly virulent with the dynamic lot-sizing routines such as part period balancing, least total cost, least unit cost, period order quantity (weeks of supply) and the Wagner/Whitin Algorithm. These dynamic routines calculate a new lot-size each time the requirements plan is generated. The new lot-sizes are then exploded through the bills of material and set requirements at the next level.

An interesting example of what can happen is shown in figure 3.

FIGURE 3

Parent

Lot-size = 3 wks On Hand = 12 Lead Time = 2 wks

Period		1	2	3	4	5	6	7	8	9	10	11
Requirements		4	2	5	2	6	4	8	3	6	9	7
Open Orders												
Available	12	8	6	1	-1	-6	-4	-8	-3	-6	-9	-7
Plnd ord Release			11			17			16			

Component

Lot-size = 20 On Hand = 15 Lead Time = 5 wks

Period		1	2	3	4	5	6	7	8	9	10	11
Requirements			11			17			16			
Open Orders						20						
Available	15	15	4	4	4	7	7	7	-9	-9	-9	-9
Plnd ord release				20								

The requirements for the parent item, after being deducted from the on hand inventory, indicate the need for a replenishment lot in period 4. The lot-sizing routine says "Add together three weeks of net requirements" and MRP schedules a planned order release of eleven in period 2, seventeen in period 5, and sixteen in period 8. These will then be requirements for a component of this item shown underneath. The balance of fifteen on hand of the component is insufficient to handle the first two requirements so a new order has just been released, scheduled for receipt in period 5.

One week later the master schedule for the end product is reduced because of a customer order cancellation. Rerunning MRP now shows that the requirement of two in period 4 for the parent has been reduced to one. (see Figure 4)

FIGURE 4

Parent

Lot-size = 3 wks On Hand = 8 Lead Time = 2 wks

Period		2	3	4	5	6	7	8	9	10	11
Requirements		2	5	1	6	4	8	3	6	9	7
Open Orders											
Available	8	6	1	0	-6	-4	-8	-3	-6	-9	-7
Plnd ord release			18			18			7		

Component

Expedite, Release Order

Lot-size = 20 On Hand = 15 Lead Time = 5 wks

Period		2	3	4	5	6	7	8	9	10	11
Requirements			18			18			7		
Open Orders					20						
Available	15	15	-3		17						
Plnd ord release	20										

The MRP program, using the reduced net requirements and the lot-sizing routine recalculates and reschedules the order quantities, getting eighteen in period 3 and 6 and seven in period 9. Exploding these orders through the bill of materials results in action notices on the component to expedite the released order and issue a new order with less than normal lead time! Why all this activity? ***Because we had a reduction in demand for its parent.*** This is completely illogical to manufacturing people and who can blame them. Just think how many changes in requirements and rescheduling messages could result from such dynamic routines applied to manufactured parts at all levels in the bills of materials. Such "phoney" action messages will be caused by all dynamic lot-sizing routines.

One suggestion that allows dynamic lot-sizing but does not cause these phony messages is to firm up the lot-sizes over the "stacked" lead time of procurement and manufacture. This means that the cumulative lead time up to this stage of manufacture must be known for each part number. As planned orders way out in the horizon, dynamically calculated, move into this time zone, then they are no longer changed automatically by the computer but made fixed quantities. The suggestion, although valid theoretically, seems to negate the benefits attributed to dynamic lot-sizing, that is its ability to adjust quantities to suit changing requirements. The additional logic and work of maintaining these stacked lead times and having them determining the period of dynamic versus static lot-sizes would also appear to have little payback.

LEAD TIME CHANGES

Lead time is subtracted from the required dates of planned orders to calculate their start dates. Any changes in planned lead times will change the planned order release dates and the requirements for components, causing rescheduling of any open orders. Some packaged MRP programs include both a dynamic lot-sizing routine and a dynamic lead time calculation. As the lot-size changes, the lead time is recalculated using the revised order quantity. When the lot-size increases, the lead time gets longer and this change of both elements causes very significant changes in requirements for components. These in turn are replanned with dynamic lot-sizing and dynamic lead time adjustments. The number of action messages resulting can be horrendous. Some programs measure the actual lead time and adjust the planned lead times accordingly. Not only does this cause the same problem of fluctuating lead times but it is exactly the wrong way to get planned and actual lead times back into step.

SAFETY STOCK CHANGES

Safety stock is often planned to protect against excess demand above the known requirements for an item. This safety stock, in most computer programs, is prededucted from the on-hand balance to calculate a quantity of inventory available to meet future requirements. Any changes to the safety stock quantity, whether introduced by statistical calculations within the MRP program or manually adjusted, may change the planned order timing for this item. Its released orders may also experience rescheduling messages, but, more importantly, its lower level components may see changed requirements and need to be rescheduled.

A form of safety stock used by many companies who produce a basic product with variants or options is overstating the master schedule for these options. These scheduled units are then "consumed" by incoming customer orders as basic units are sold with various options. At that time unused options in the master schedule are rescheduled to a later date or are cancelled. These actions will cause rescheduling messages on the components of the options.

ENGINEERING CHANGES

I have yet to meet a manufacturing manager who does not believe he has too many engineering changes. Even in very simple products such as chewing gum, pharmaceuticals, etc. the engineering changes appear to be excessive. All changes to bills of material will change requirements within the MRP program. The sooner the change is required to be implemented the more the affected components will be rescheduled. Changes that can be phased in sometime in the future can be implemented without significant rescheduling.

RECORD ERRORS

The MRP program demands accurate data for it to perform its planning function. The on-hand inventory quantity for each part is netted against this part's requirements. Replenishment orders are also netted against requirements as well as being used to determine whether these orders are scheduled for the right time period. Allocation balances (material reserved for a specific customer or job order) are subtracted from the inventory on-hand before the netting routine occurs. Bills of material are used by the MRP program to relate component requirements to parent orders. Errors in any of these data will result in many rescheduling messages when corrections are made.

UNPLANNED TRANSACTIONS

MRP will plan material based upon all of the known factors that will affect the inventory position. Any unplanned transaction that changes the inventory level for an item will alter the planning to replenish this item, which will cause a chain reaction through all levels in the bills of material, causing rescheduling messages.

ATTACKING THE CAUSES

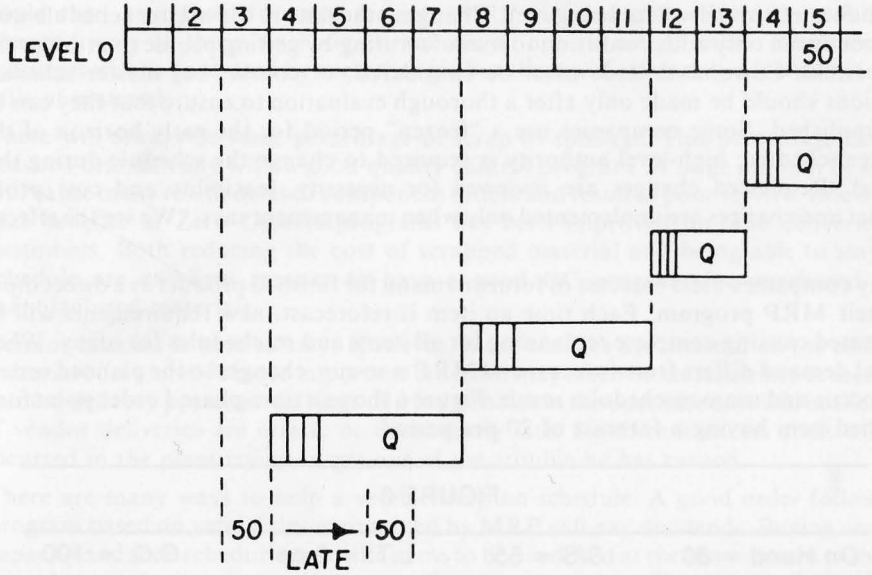
The previous sections showed the many reasons why rescheduling messages are generated in MRP-based programs. Most of the literature and presentations on the subject of rescheduling have dealt with handling this rescheduling load within the plant or with vendors. A much more productive approach is to reduce the number of reschedules down to those that are absolutely necessary and then get prepared to handle these few.

The emphasis with dynamic systems should not be on rescheduling to get out of trouble but on making the plan happen. The earlier descriptions of MRP stressed its replanning capability, and MRRP (Material Requirements Replanning) was often heard. That is ***not*** its prime function, however. Its job is to break a master production schedule for a plant into detail plans for each part number affected, but then stress must be on ***executing*** the plan. Only when all avenues have been explored and there is no feasible way to solve a limiting problem should the plan be changed. And this change should be made bearing in mind the affect this will have on all other related items. For example: a vendor is going to be late delivering some material (see Figure 5). The real questions should be, "Can we get back on schedule?" and "Can we collapse the lead times internally and still make the finished product as originally scheduled?" This will minimize the need to reschedule many of the related components and allow the plant to operate with minimum disruption.

For most of the causes the number of reschedules can be reduced significantly or eliminated completely by attacking the basic problems. Consider record errors. A program should be established to minimize errors; it is possible to improve dramatically the accuracy of the records. Experience indicates that approximately half of the average company's part number inventory records have "On Hand" and "On Order" balances which are ***significantly*** inaccurate. With incorrect data, no formal

Figure 5

Master Production Schedule



system can provide the information necessary to run a plant effectively. Few plants have a specific program designed to improve this state of affairs. This record accuracy program should be concerned with all the important records; these include on-hand balances, open order balances, allocated material balances, and, probably the most important of all, bills of material. Several companies have made significant progress in a very short time with conscious effort to improve record accuracy. They have found it doesn't cost much and is well worth the effort. It is not a glamorous job, but a tedious one demanding management time and attention. In one company, on-hand inventory figures were improved from 65% to 95% accurate in a few months at very little cost. With a good systematic approach equally significant strides can be made in cleaning errors out of open order balances, allocated material balances and bills of material. Not only is there no excuse for grossly inaccurate records causing many rescheduling messages, but eliminating record errors may be the best profit improvement program you can find!

Over-sophistication can cause serious trouble using dynamic lot-sizes and dynamic lead times. These are deadly to any MRP-based system because of the spurious action messages they create. They are interesting mathematically but have little real value in a well-run material control system. The formulas for calculating a so-called "economic" order quantity do not consider many relevent factors such as people or machine capacity, bulk, component availability, etc., and the numbers used in the formulas are estimates, not precise data. The dynamism of these techniques in an MRP-based replanning system causes problems which are not offset by the economies of precise calculations. ***Fixed*** lot-sizes or lot-for-lot ordering and ***fixed,*** short lead times should be established for each item; these should not be allowed to change without approval of the top man in materials control, hopefully, very infrequently.

There are some techniques that can be used to minimize the effect of inevitable changes. Probably the most crucial one is managing the master schedule. Changes to the master schedule can affect every level in the bill of materials and special care must be

taken to ensure that such changes are necessary and can be accomplished. Many companies change their master schedule without determining whether or not the change is feasible. There is no sense in advancing a customer's delivery date if there is no chance of this new date being met! Changing the date in the master schedule with this condition only adds confusion to manufacturing by getting people to attempt the impossible. Customers needs must be considered, of course, but master schedule revisions should be made only after a thorough evaluation to ensure that they can be accomplished. Some companies use a "frozen" period for the early horizon of the master schedule; high-level authority is required to change the schedule during this period. Requested changes are reviewed for necessity, feasibility and cost/profit impact and changes are implemented only when management says, "We see the effects. Go!"

Many companies use a forecast of future demand for finished product as a direct input to their MRP program. Each time an item is reforecast, new requirements will be generated causing complete replanning for all items and reschedules for many. When actual demand differs from forecast and MRP is re-run, changes to the planned orders will occur and more reschedules result. Figure 6 shows a time-phased order point for a finished item having a forecast of 20 per period.

FIGURE 6

On Hand = 80	S/S = 55	L.T. = 2 per.				O.Q. = 100		
Period		1	2	3	4	5	6	7	8
Forecast		20	20	20	20	20	20	20	20
Sched. Receipts			100						
Available	25	5	85	65	45	25	5	-15	-20
Plnd. Ord. Receipts								100	
Plnd. Ord Release						100			

Planned orders are generated, considering the 80 pieces on-hand, the 55 pieces for safety stock and the open order for 100 pieces. The forecast is an average and actual demands in each period will differ from the average. If 26 pieces are sold in period 1 instead of the 20 forecast, the planned order release of 100 in period 5 will move to period 4, causing expediting of lower level items. However, if the forecast is a true average of actual conditions, then the chances are that only 14 will be sold in period 2. This will shift the planned order release back to period 5 slowing down the items that were just expedited.

But safety stock should buffer these variations from the manufacturing system. ***The master production schedule is the planned order release of 100 in period 5 and the system should not move it.*** The "Firm Planned Order" technique forces the system to use the safety stock to absorb the variations of actual demand from forecast. The planned order release should only be considered for change if the actual variations from plan deplete or build up the safety stock significantly. The same logic applies to forecast changes. MRP should not be driven by a forecast but by a master production schedule.

Spare parts demand for each item is normally forecast independently and added directly to gross requirements calculated by MRP to support production of parent items. There is no chance in most cases of being able to master schedule each item that has repair parts sales. A workable approach is to identify those major assemblies that

are also sold as repair parts and develop individual master schedules for them. Safety stock for these items will provide the same buffering as for finished products. Other items at lower levels in the bills of material and purchased items at the bottom levels could then have fixed forecasts fed into MRP automatically. Forecasts would be changed only if there were significant deviations in actual sales. Rescheduling messages will be generated by such changes but these will affect only a few items in the bills of material.

There will always be some percentage of scrap or spoilage. This percentage can be reduced dramatically with a good quality control program. A large amount of scrap will cause many reschedules of component orders and result in poor service. One of the real benefits in Zero Defects programs has been improved on-time deliveries to customers. Both reducing the cost of scrapped material and being able to stay on schedule are excellent reasons to have a good QC program for purchased and manufactured materials.

Vendor lateness is here to stay. However, most vendors are selected on the basis of material cost alone. A more important criterion may often be his reliability in meeting quoted delivery promises. Savings of a few pennies in the purchase cost will be illusory if vendor deliveries are erratic or consistently late. Significant excess costs will be incurred in the plant trying to get out of the trouble he has caused.

There are many ways to help a vendor keep on schedule. A good order follow-up program based on valid dates maintained by MRP will pay dividends. Buying vendor capacity and then scheduling specific items to be produced at the last moment with this capacity can do wonders to improve delivery performance. The approach of always delaying as many parts as are being expedited is also a good rule to use.

Plants fail to meet schedules because of machine breakdown, tooling failures, absenteeism or quality problems. Each one of these should be attacked with a program specifically designed for it. Preventive maintenance programs should keep machines running so the plant can stay on schedule. Similar programs are necessary to insure that tooling will be functioning when needed. Many companies add tooling to bills of material so that MRP can generate information on the dates tools will be needed, especially for consumable tooling. This information can be used to schedule preventive maintenance on machines and to give a schedule of needed tools to the tool room. Significant improvements in machine and tooling availability mean fewer reschedules, less frequent upsets and better deliveries.

Engineering changes will never be eliminated. As George Plossl put it, "Engineering changes occur in direct proportion to the number of engineers on the payroll". Technological advances must be incorporated in product design. The problem is how best to handle them. One way is to schedule their introduction well in the future; it is close-in, short-term changes that cause most of the rescheduling problems. Taking time to use up existing inventory or scheduling the change to suit the manufacturing facility will minimize reschedules. In one company every "mandatory" change was considered an Engineering "bust" and all costs associated with making it were charged to the Engineers' budget. In this company, most engineering changes are phased in to use up available materials; less than 5% become the emergency "short fuse" kind of change. Another approach well worth considering is the "block change" used by the automobile companies and many others. Under this technique, all changes are scheduled to take effect at one time in the year on each specific product. The automobile companies make most of their engineering changes at the model year change-over. Only a few, called "Ralph Nader changes", occur during the year. This not only minimizes rescheduling of orders but also eases greatly the problem of

identifying the proper repair parts and provides stable, accurate bills of material for a whole year.

Safety stock changes will sometimes be necessary. However, calculation routines should not be allowed to change this number after every forecast revision or every variation in actual sales from forecast. Rescheduling can be minimized if safety stocks are changed only when ***significant*** forecast changes or errors occur.

The idea of overstating the master schedule for options planning is an excellent one (2). As options are rescheduled to a later date, though, this will generate rescheduling messages on the unique components. There are no ways of minimizing these kinds of changes; this penalty is more than offset by the advantages of overplanning options and improving customer service.

There are always good reasons for unplanned actions within a plant. The engineers require material to perform some tests. Marketing would like to have some units to show a customer. The maintenance department needs some production material. Many of these transactions, however, are not necessarily urgent and could be delayed if they cause significant upsets. Analyzing the effects of these demands on inventory before they are processed and stock withdrawn permits inventory control personnel to minimize rescheduling. A tight control on such unplanned transactions can frequently help eliminate record errors. Assembly having too much or too little material might indicate bill of materials problems, poor scrap reporting on the assembly floor, wrong counts issued from the stock room, etc. These unplanned transactions should be analyzed and the causes identified so that corrective action can be taken to eliminate or reduce them.

Short lead times on all parts, whether purchased or manufactured, can reduce the number of reschedules. Figure 7 shows a five-level bill of materials with a quantity of 50 in the master schedule in period 15 indicating the need for 50 castings to be ordered now. Reducing lead times by one week at each level would bring the quantity in the master schedule causing this order to be placed back to period 10. Obviously, the shorter the overall manufacturing cycle time, the more firm the plan will be and the less chance of reschedules on any of the components. Dramatic reductions can be made in the number of reschedule messages with short lead times, without considering the additional benefits of lower work-in-process inventory.

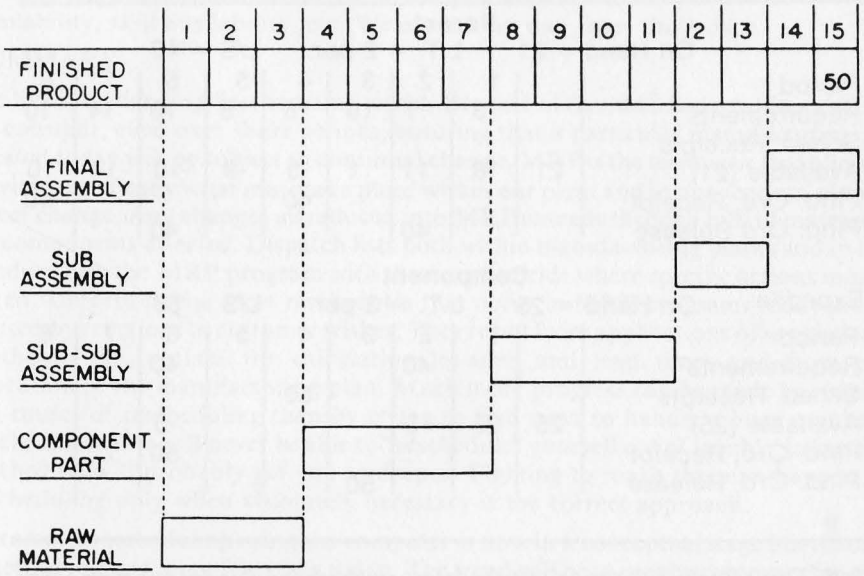
HANDLING THE BALANCE

Some companies apply dampening rules to limit the number of reschedule notices put out by the system. A typical rule would be to ignore an "Expedite" message of only one week or "Reschedule later" less than two weeks. Only those action messages that exceed these limits are reported out of the computer program. The danger with such dampening rules is to overlook actions that should be taken. There are many times when a reschedule within these limits can and ***should*** be seen and action taken.

Another rule that has been suggested for purchased material is to create "fences." These fences would suppress action messages in the short term, say two weeks out, as well as the long term, beyond say, ten weeks out. These recognize a vendor's limited ability to change a delivery that is less than two weeks away, as well as his lack of interest in a change to a long term delivery date. Again the question is whether knowing about suppressed order reschedules is significant to your vendors or not. (See reference #3 for further discussion on rescheduling dampening.)

Some rescheduling in the plant can be eliminated by corrective actions within the materials control area. Figure 8 shows a parent and component where the latter has an exception condition requiring a reschedule.

Figure 7
MASTER PRODUCTION SCHEDULE



Splitting the parent planned order lot-size eliminates the need to reschedule the component. A change in a lot-size several levels up in the bill of material may overcome a particular constraint on a lower level item. This change will cause delaying messages on the other components that make up this parent, so this approach should only be used when the original reschedule messages cannot be handled easily. As long as there are no major cost or capacity penalties, lot-size changes are a feasible way of insuring that the master schedule still can be met. The firmed planned order technique can be used in conjunction with pegging to solve reschedule conditions but still support the master schedule.

A "firm planned order" has its quantity, due date and start date set manually and they cannot be adjusted automatically by the computer. This contrasts with a normal "planned order" which can have the quantity, start and due dates automatically adjusted by the MRP program using the planned order quantities and lead times. Both firm planned and planned orders are exploded downwards to post gross requirements on lower level items. The firm planned order technique is very useful in handling reschedules. Figure 5 shows an example of a vendor who will be three weeks late on a given order so that the next higher level item cannot be manufactured on time. The other components going into this next higher level item should have their requirements changed to a later period to keep the priorities valid. The firm planned order routine allows adjustment of lead times for this series of orders only, to get the MRP program back in step.

A way to transmit necessary rescheduling messages from the MRP program into the plant is through a shop schedule, usually called a dispatch list. After the planner has reviewed the requests for rescheduling and approved a change, the open released order in the plant must have its due date or priority changed accordingly. To do this manually on all the released orders in a plant would be very cumbersome and time consuming. A dispatch list eliminates the need for dates on shop order paper. Usually issued daily, it tells the foreman the priority that he should follow when working on

FIGURE 8

Parent

On Hand = 21 L.T. = 2 per L/S = 40

Period		1	2	3	4	5	6	7	8
Requirements		3	7	10	6	8	10	14	10
Sched. Receipts									
Available (21)	21	18	11	1	-5	-8	-10	-14	-10
Plnd. Ord. Receipt					40				40
Plnd. Ord Release			40				40		

Component

Expedite. On Hand = 25 L.T. = 3 per L/S = 50

Period		1	2	3	4	5	6	7	8
Requirements			40				40		
Sched. Receipts					50				
Available (25)	25	25	-15				-5		
Plnd. Ord. Receipt							50		
Plnd. Ord. Release				50					

each job. This priority list can reflect the latest rescheduled due date of each order. An expedite message, after approval by the planner, can cause this order to move up the priority list and receive attention earlier. A delaying message would operate in the reverse manner; the foreman could set that job aside and work on more urgent ones.

This same concept is slowly being applied to purchased material. Some companies view the vendor as an "external work center" rather than a separate company. For many commodity-type items such as castings, forgings, bearings, glass bottles, etc., all coming from the same basic raw material, the vendor does not need to know too long before the delivery date which specific item is required. As long as he has enough raw material and capacity to meet a customer's needs, he can work to actual delivery schedules at the last minute. In this environment, the dispatch lists used internally in the plant could also be used with vendors.

Still another way of handling purchased items is to establish a fixed schedule taking up to 90% of the capacity that a vendor is willing to commit to a customer. Reschedules can be requested within the 10% remaining capacity that the vendor has allocated to the customer. This gives advantages to both: the vendor knows the bulk of his business will be fairly stable with only a small amount of flexibility; the customer knows that he can get a few "hot orders" when he needs them.

Some people have been thinking recently about having the computer automatically reschedule open orders. (3) The problem with this approach is that the computer very rarely "knows" all of the factors that must be considered when making a rescheduling decision. Will the tooling be available and operable at that time? Will the component material be available? Is there adequate capacity and needed skills available in the work centers or can alternate operations be used to get the material through? Automatic rescheduling has very little application in industry; the major decisions should be made by the planner. It is possible, as we learn more about reactive MRP-based systems, that ways will be found to allow the computer to make more decisions. This will require a much larger, better integrated data base than those in existence

today, as well as a much more reactive overall system. The effects of reschedule changes could then be examined both on the item and its components several levels down in the bill of materials on the capacity of all work centers involved, on tooling availability, skill availability, etc. We are a long way from this now.

SUMMARY

We live in a changing, fast-reacting world. Because of this, demands on plants will not be constant, even over short periods, ensuring that a particular manufacturing plan created today will be subject to continual change. MRP is the technique that allows us to view specifically what must take place within our plant and in our vendors' plants to effect change. Any changes introduced into MRP cascade through bills of material on all components affected. Dispatch lists both within manufacturing plants and in their vendors link the MRP program with these real worlds where specific actions must be taken. Unfortunately, most reschedules that occur in MRP programs today are not caused by reactions to customer wishes. They result from applications of sophisticated mathematical routines for calculating lot-sizes and lead times and from poor execution of the manufacturing plan. Much more progress can be made by reducing the causes of rescheduling than by trying to find ways to handle a huge number of reschedules. You will never be able to "reschedule" yourself out of trouble; in fact each reschedule will probably get you in deeper. Fighting to make the plan happen and rescheduling only when absolutely necessary is the correct approach.

Automatic rescheduling using the computer is now in a conceptual stage but is not yet practical in most manufacturing today. The trend will be to use the computer for more rescheduling decisions as we improve the system's ability to tie together MRP with capacity data, labor information, tooling status and component availability.

Rescheduling is here to stay. We must keep valid priorities on jobs in the plant and react to necessary change quickly. We must, however, eliminate unnecessary changes. MRP-based systems generate sound plans; we must learn to execute these manufacturing plans within the plant and with vendors. Adequate execution of plans includes handling required changes via the formal system in lieu of our present informal way of reacting to all changes after they have occured.

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